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ABSTRACT

In an investigation of the "shaping" function of postquestions in prose and of a new methodological approach, fifth-grade children read forty text cards, each consisting of four attributive statements. Each card was followed by an experimental question, which during training tested information related to specified concepts or positions, or randomly tested recall. In subsequent test trials, all questioning was random. Learning curves developed for all four nonrandom groups, and same-type item performance was disrupted for three during random questioning. The single concept group was superior to the random on shared items and showed marked latency increases with the onset of random questioning. Implications of the methodological paradigm and appropriateness of the "shaping" descriptor for such learning were considered. (Author)

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Abstract

The Experimental Development of Reading Strategies in Children

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In an investigation of the "shaping" function of postquestions in prose and of a new methodological approach, children read 40 text cards, each consisting of four attributive statements. Each card was followed by an experimental question, which during training tested information related to specified concepts or positions, or randomly tested recall. In subsequent test trials all questioning was random. Learning curves developed for all four nonrandom groups and same-type item performance was disrupted for three during random questioning. The single concept group was superior to the random on shared items and showed marked latency increases with the onset of random questioning. Implications of the methodological paradigm and appropriateness of the "shaping" descriptor for such learning were considered.

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The Experimental Development of Reading Strategies in Children

Taking Rothkopf's conceptualization and explication of mathemagenic behaviors (Rothkopf & Coke, 1963; Rothkopf, 1965) as a starting point, a number of researchers have demonstrated the efficacy of inserting questions following reading passages on learning from such materials (e.g., Frase, 1968; Bruning, 1968a; Natkin & Stahler, 1969; Watts and Anderson, 1971). Within the general area of prose learning research, a recurring theme has been the attempt to develop specific reading and review strategies by such post-questioning procedures. This approach has no doubt been stimulated, at least in part, by the fact that the development of focused strategies for processing textual materials, coupled with a systematic delineation and understanding of these processes, has considerable importance to the educational community. If, for example, the potential exists for reliable development of subcomponents of reading such as attending to or ignoring contextual variables, searching for particular classes of information, or drawing inferences, the availability of such technologies would greatly enhance the instructional capabilities of our educational systems.

One view of the function of such post-questions is that the question event functions as a consequence for behaviors which precede it, serving to selectively reinforce or "shape" these behaviors (Rothkopf, 1965; Rothkopf, 1970; Frase, 1970; McGaw & Groteleuschen, 1972). In general, however, findings regarding a "shaping" function for post-questions have been equivocal to this point. Frase (1968) found consistent effects but no significant improvement over 20 paragraph-question blocks, leading him to conclude that facilitation which occurred was not acquired in the course of the reading task; that is, the requisite

behaviors did not appear to be shaped by post-questions, but rather involved the maintenance of previously learned skills. In contrast, Morasky and Willcox (1970) found that differences in time spent reading developed in later passages between question-before and question-after groups, findings supporting a shaping hypothesis. Rothkopf and Bisbicos (1967) found that posttest performance was facilitated on some item types encountered as experimental questions but not for others, with effects associated with later portions of reading. Bruning (1968b) employed materials structured in subordinate-superordinate form with review questions drawn from each level, but selective facilitation was present only for subordinate level post-questions on subordinate level posttest items. While Watts and Anderson (1971) found general facilitation for application-type experimental questions across a variety of posttest item types, performance was not necessarily enhanced on item types earlier encountered as experimental questions. Also, performance on posttest items relating to later portions of the reading and on later experimental question was not improved, both findings also inconsistent with expectations based on a shaping hypothesis. Like Watts and Anderson (1971), McConkie and his associates (McConkie, Rayner, & Wilson, 1972) have demonstrated effects of question-type on reading speed, but there were no significant effects of this variable on overall posttest performance, nor was within-class superiority consistently apparent on posttest items (e.g., recognition and higher order question groups performed poorly on their respective item types on the posttest).

Frase (1973) has recently called for an examination of methodology in the study of prose learning phenomena, a point having particular cogency to examination of the shaping hypothesis. For the most part, investigation of the viability of this conceptualization has taken place under conditions which were not necessarily well designed with regard to either demonstrating or understanding these phenomena.

For example, with few exceptions experimental subjects have been adults, likely to have already well-developed reading strategies quite possibly resistant to short term manipulation. At the same time, the hypothesized behavior chains terminating with the question contingency must, of necessity, be exceedingly complex, given the usual methodological paradigm of insertion of post-questions following relatively large blocks of prose with generally unspecified characteristics, (see Frase, 1973; Carver, 1972). A related issue involves a need for clear definition of conceptual categories represented both within the materials and by post-questions, certainly problems of considerable magnitude for research of this type. Also, the relatively small number and relatively infrequent encounters with such questions in several studies perhaps do not comprise a set of conditions well suited to selective development of complex behavioral chains.

The present suudy, while conceptually consonant with prior research, represents a departure, methodologically, in the analysis of prose learning phenomena. Although the basic experimental paradigm, consisting of prose unit presentations with alternating questions was employed, both the materials and the reading strategies analyzed were reduced in complexity. Materials were constructed with standardized format and content, with text units to be read consisting of short four-sentence sets specifying attributes of countries. Attributes represented four concept classes, with multiple presentations encompassing forty selected nations. Attributive statements were randomly assigned four to a text card in a double column format, with each concept class represented once per card. The experimental questions following each text card, repeatedly focused on one of the following: (a) a single concept (b) a single position on the card (c) two concepts (d) two positions or (e) randomly tested information presented on the text card. Children served as subjects and performance on the experimental questions, together with reading latencies,

was continuously monitored across twenty training trials, where questioning was consistent with the development of one of the strategies, and twenty "test" trials where questioning shifted to a random presentation condition.

It was hypothesized that, if a reading strategy were being acquired, then performance on questions during training should show improvement across trials. Additionally, comparisons on questions shared by a strategy group and the random group should show superior performance for the strategy groups. A subsequent shift to random questioning, it was argued, should result in an increase in reading latencies relative to those on the training trials, based on the assumption that there would be general deterioration in performance if a strategy had been adopted and that such deterioration would lead to increased concentration on the textual materials. At the same time, a decrement in performance was predicted in related item categories for associated strategy groups between the latter portion of the training trials, where a strategy would have been operative, and the test trials, where the strategy would be repeatedly disconfirmed by the random questioning.

Method

Subjects:

Subjects were 50 sixth-grade students enrolled at a public elementary school. Because pilot analyses indicated that task requirements were relatively difficult for pupils of this age, only students whose total language score on the Iowa Test of Basic Skills was above grade level (grade 6.0) were selected from among the sixth grade population. Mean total language score on the ITBS of participants was 7.19. Subjects were drawn from five separate classrooms and randomly assigned to experimental conditions.

Materials:

Task materials encountered by subjects consisted of eighty 5 by 7 inch cards, 40 text cards presenting four typewritten statements, alternating with 40 question cards which tested information from the immediately preceding text card. Basic text and question materials were derived from a listing of 70 new or emerging nations drawn from a recent atlas, with a selection of attributes for each nation. These attributes included capital, major rivers, exports, constituent populations, bordering nations, and so on. Inspection of the total matrix of nations indicated that four attributes (capital, major river, bordering country and monetary unit) had similar verbal characteristics for a sufficient number of nations to permit their use in constructing the final set of materials. General criteria for selection required a low probability of prior subject acquaintance with the nation, that the attributes consist of a pronounceable single word of from five to nine letters, and that an attribute was not repeated for other nations within the same category. However, within the other parameters delineated, this latter requirement was not always possible.

Sentence format for materials was standardized to mitigate against inadvertently providing discriminable information not relevant to the variables under investigation. The format for each category was as follows:

The capital of ___(name)___ is ___(name)___.

A country near _____ is _____.

The monetary unit of _____ is the _____.

A major river of _____ is the _____.

The final set of materials, identical across all trials for all subjects, consisted of the four attributive sentences for 40 nations, totaling 160 statements. To construct the text cards, two randomizations were required. Statements within each attribute class (e.g. statements about capitals) were

randomly assigned to one of the 40 trials. A second randomization determined the position of attribute statements on the card. Items were positioned in a double column format, with position 1 and 2 located on the left hand side and position 3 and 4 located on the right. Vertical separation of items was approximately 5 cm. and horizontal separation about 3 cm. Each question card consisted of a statement from the preceding text card, typed in the middle of the card, with the selected attribute deleted. Variations in these questions constituted the experimental manipulation in the present study.

During twenty training trials, subjects in each of the five groups answered questions intended to develop a particular strategy for reading the materials. In the first group, a Single Concept condition, all questions during training tested knowledge contained in the capital statement presented on the preceding text card, while the second group, a Single Position condition was tested on information appearing in position 2, the lower left position, on the text card. Thus, in the single concept group, information tested may have appeared in any of the four positions on the preceding text card, while for the single position group, each of the four concept classes had an equal probability of being tested. In a third group, a Double Concept condition, questions during training tested information about either capitals or rivers, with order determined randomly across trials, while a fourth group, a Double Position condition, encountered questions exclusively relating to text sentences in positions 2 and 3 (lower left and upper right sentences). Again, specific position, 2 or 3, for a given trial was randomly determined. A fifth group, a Random condition serving as a control group, received questions randomly selected from the four sentences on the text card, with all sentences and positions equally likely to be questioned.

During the test phase, the final twenty trials, questioning became

random for all groups subject to the restriction that the initial test trial constitute a disconfirming instance for the four non-random strategy conditions. Thus all groups now encountered random questioning, a procedure involving no change for the random position condition. The card deck consisted of both training and test phases, with no features separating the former from the latter, except for the potentially discriminable shift in questioning for the non-random strategy groups.

Procedure:

All subjects were individually tested by the experimenters. Each subject was presented with a card deck for his assigned treatment condition. Instructions read to the subject indicated that the purpose of the study was related to a general interest in how children read, and discriminated between the present situation and examination settings. Subjects were instructed to read each text card "as quickly and as carefully as possible," that each card would be followed by a question to be answered in writing on a provided sheet of paper, that the rate of progress through the deck was under his control, and that the experimenters were not interested in the accuracy of the spelling of the various names. Three warm-up trials, involving information on three familiar nations, were employed; the first warm-up trial demonstrated the procedure to be followed, the second and third allowed the experimenters to monitor the efficacy of the instructions. A blank card signaled the end of the warm-up trials and allowed time for the experimenters to answer any procedural questions submitted by the subject. All sample items for each group were consistent with the strategy to be encountered in the following card deck. Immediately following the sample items, but prior to the training

trials, the scoring key, operated by the experimenters, was pointed out to the subject, together with a brief statement regarding the necessity of externally recording the subjects responses. The recording apparatus itself was shielded from the subject by a plywood panel.

Progress through the text and question materials was monitored on an event recorder (Gerbrands, Model P2-C6), with reading latency, testing latency and correct or incorrect response scored for each subject by the experimenter, positioned approximately .5 meter to the right of the subject. Written responses were judged as correct or incorrect on the basis of phonetic correspondence with the actual response; e.g. if the response, pronounced by the experimenter as written, corresponded with the actual pronunciation, it was scored correct. During warmup, training and test trials, noncontingent verbal reinforcement was provided by the experimenters to maintain task performance. After completing his session, each subject was questioned by the experimenter concerning his perceptions of the difficulty of the task, overt awareness of the questioning contingency encountered, and whether he had concentrated on any particular aspect of the text cards while responding.

Results:

The proportion of items correct across training trials for each of the experimental conditions is presented in Fig. 1. Since each curve represents

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Insert Fig. 1 about here

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the number of items correct within that particular training condition, and the items in each trial block represent a random subset of items of that type, separate repeated measures analyses of variance were conducted for each group. Significant gains in number correct were revealed for the

Single Concept group (F = 12.57, 3/27 df, $p < .001$), the Single Position group ($F = 4.40$, 3/27 df, $p < .025$), the Double Concept group ($F = 12.88$, 3/27 df, $p < .001$), and the Double Position group ($F = 10.57$, 3/27 df, $p < .001$), while changes in the Random group were not significant ($F = 1.25$, 3/27 df, $p > .20$).

As questions in the Random condition were randomly assigned, both during training and test phases, the number of questions shared across strategy groups varied. During the training phase, questions were identical for Single Concept and Random groups on trials 3, 5, 8, 11, 15, and 17; for Double Concept and Random groups on trials 5, 9, 11, 15, and 16; for Single Position and Random groups on trials 8, 9, and 17; for Double Position and Random groups on trials 2, 9, 12, and 18. A significant difference was obtained in favor of the Single Concept group over the Random group on shared items ($\overline{X}_{SC} = 4.6$, $\overline{X}_{R} = 2.2$; $t = 3.60$, $p < .001$), while no other comparison with the Random group on shared items was significant.

Analysis of mean reading latencies across training and test trials, transformed logrithmically, indicated significant changes over trials ($F = 24.70$; 7/315 df; $p < .001$), no significant main effects for conditions, and a significant conditions by trials interaction ($F = 2.74$; 28/315 df; $p < .001$). Inspection of Fig. 2 reveals a sharp increase in reading latency occurring by the second trial block for all conditions, an effect apparently

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Insert Fig. 2 about here

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resulting from subject adjustment to the relatively more difficult reading/recall task presented by the training trials in comparison to the warm-up trials. Additionally, in relation to the trials by conditions interaction, one can note a marked upward shift in latency for the Single Concept group

with the onset of test trials, providing support for the hypothesis that a reading strategy had been adopted during training and was disrupted by the onset of the random questioning of the test trials.

Two features of the error data during random question test trials are pertinent to questions of establishment and persistence of reading strategies. If a reading strategy had been adopted during the training trials and persisted during the test phase of the study, the proportion of items correct during random questioning which were consistent with that particular strategy should be significantly higher than proportion of correct items from other categories. Comparison of the Same and Other columns in Table 1 shows that this was not the

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Insert Table 1 about here

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case, but that almost complete disruption of the strategy appeared to occur. Supportive of this view are the comparisons between proportions correct for each subject on the last five training trials and the proportion correct on strategy-consistent items appearing during test trials. Since such items represented random subsets of item pools of that type, differences may be attributed to the development and subsequent disruption of a reading strategy, or to general factors for which the Random group should serve as a control. Comparison of proportion scores for the Random condition in the last five trials of training and on test trials showed no significant change ($t = 1.25$, 9 df, $p > .20$). However, similar correlated t tests for the strategy groups indicated significant declines in performance for the Single Concept group ($t = 8.16$, 9 df $p < .001$), the Single Position group ($t = 2.69$, 9 df, $p < .025$), and the Double Position group ($t = 4.13$, 9 df, $p < .003$) but not for the Double Concept group ($t = .99$, 9 df, $p > .30$).

Correlational analysis revealed non-significant relationships between ITBS total language scores and number of questions correct during training, test or total trials for the entire group. Similar non-significant relationships to number correct during training and test trials also held for training and test latencies.

Discussion

Results of the present investigation support the contention that postquestion manipulation can influence the acquisition of and, conversely, disrupt certain reading strategies employed by children. In particular, for the Single Concept group, the evidence clearly indicates the development of specialized modes of responding during reading tasks, with improvement in performance over trials, and significant facilitation on shared items compared to random questioning. Additionally, with the change in contingency introduced by the random questioning during test trials, strategy disruption is indicated directly by the deleterious effects on same-type item performance and indirectly by the sharply increased reading latencies. For the other non-random groups, significant performance improvements across training trials were present and, for all but the Double Concept group, significant decrements occurred on related item types with the introduction of random questioning.

The present data, based on children's responses, extend the generality of an earlier observation by Frase (1968) that persons tend to approach written materials with pre-developed modes of interaction; i.e., strategies either confirmed or disconfirmed by postquestioning. Examination of Fig. 1 provides indication that the initial effect of regularizing the reading/questioning contingency was not necessarily to improve performance but rather may have been to produce decrements in performance level. It would appear that efficient processing developed in the strategy groups only after repeated trials, in that in

early performance under random questioning was relatively better than performance in the strategy groups. Although items are not strictly comparable across conditions, one would predict substantially higher performance for all of the strategy groups, given that the necessary reading/retention load for these groups was only one-fourth to one-half of that of random questioning. However, the modal pre-experimental reading strategy of children in the present study appeared to be to read and process all the textual information, a strategy consistent with random questioning requirements.

Selective-focus postquestion arrangements appeared to be initially disruptive for all but the simplest of questioning arrangements, the Single Concept arrangement. It seems likely that any perceived regularity in questioning, albeit only an apparent regularity produced by randomization, may have led to relatively rapid strategy selection on the part of the subject. The strategy selected, however, may not have necessarily been congruent with the actual questioning contingency in force for the subject's experimental group. In the present study, subsequent improvement was gradual over trials; with more sophisticated subjects, one might expect rapid and relatively decisive shifts in strategy on the basis of increased skill in contingency identification. For example, most adults might be expected to adopt the Single Concept strategy of the present study in one or two trials.

As a descriptor for the experimental method and learning processes involved in this and earlier studies of directed-focus adjunct questions, the behavioral shaping analogy would appear to be realitvely inadequate. Major features of the shaping process, as it has been traditionally approached in the literature, involve the development of a new behavioral repertoire, previously nonexistent, by means of reinforcement of approximations to a requisite terminal performance. Generally however, the experimental arrangements within the mathemagenic framework have not been conceptualized to provide for the reinforcement of approxima-

tions to a requisite terminal performance, but rather have employed the question-event as a fixed criterion for terminal performance, an arrangement more closely analogous to a discrimination learning paradigm. Also, improvement in performance appears to depend not so much on the development of a new repertoire of responses as it does upon selective confirmation and disconfirmation of pre-existing behaviors and strategies. Within the Skinnerian framework, such processes seem more adequately described as precurrent behaviors (Skinner, 1968, p. 121); behaviors which while not directly reinforced themselves, function to make subsequent behavior more likely to be positively confirmed.

The facile adoption of appropriate strategies seems most clearly dependent upon the identifiability of concept classes represented by post-questions and existing within the task materials, and learner skills in mediating his performance in terms of such recognition. Among the questioning arrangements employed, the Single Position arrangement imposed the least demanding behavioral requirement upon subjects, requiring only that subjects process textual information from a single location. Relative gains in performance, however, show much more pronounced effects for the Single Concept group, suggesting that such content-based concepts have a functional history easily represented within questions, whereas questions have seldom functioned in relation to positional orientation and hence are less recognizable in reading tasks. In contrast to the Single Concept arrangement, the Double Concept condition presented what was essentially a disjunctive concept attainment task, with difficulty further increased by the serial nature of feedback in all conditions. Indeed, comparisons on shared training items (N = 10) between the Single and Double Concept groups showed significantly poorer performance for the Double Concept group on such items ($\overline{X}_{SC} = 7.5$, $\overline{X}_{DC} = 3.8$; $t = 4.60$; $df = 18$; $p < .001$).

From a methodological standpoint, the "shift" method employed appears to be potentially productive for investigation of a number of strategy/materials interactions and strategy/strategy interactions in learning from text. With regard to such questions, the present study was conceptualized as a first-level exploration of effects of simple conceptual and positional contingencies upon processing of materials of limited complexity. However, the investigative model seems also applicable for higher order investigations of interactive effects of basic strategies and behaviors as components of more complex analytical skills, (e.g., the effects of training in hypothesized sub-skills upon inference making from various types of textual materials), for the investigation of the function of mediating processes in learning from text, and for investigation of adaptive processes given variation in text characteristics. Given the relatively straightforward nature of the basic arrangements involved and sophistication of methods for textual analysis, methods and materials developed within this paradigm may contribute to the development of effective training procedures to teach children and adults important skills in information processing from written materials.

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Table 1: Proportions correct of given item types for associated strategy groups during the final 5 training trials and during the test trials.

Item Type-Group	Training		Test			
			Same		Other	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Single Concept	.94	.10	.37[1]	.17	.40	.22
Single Position	.52	.25	.33	.15	.33	.22
Double Concept	.50	.24	.40	.26	.45	.31
Double Position	.60	.19	.30	.18	.28	.21
Random Position	.46	.21	.38	.23	___	___

[1]For the 20 test trials, N of Single Concept items = 6, Single Position = 10, Double Concept = 16, Double Position = 13, and Random = 20.

Fig. 1: Mean correct responses to experimental questions within blocks of 5 training trials.

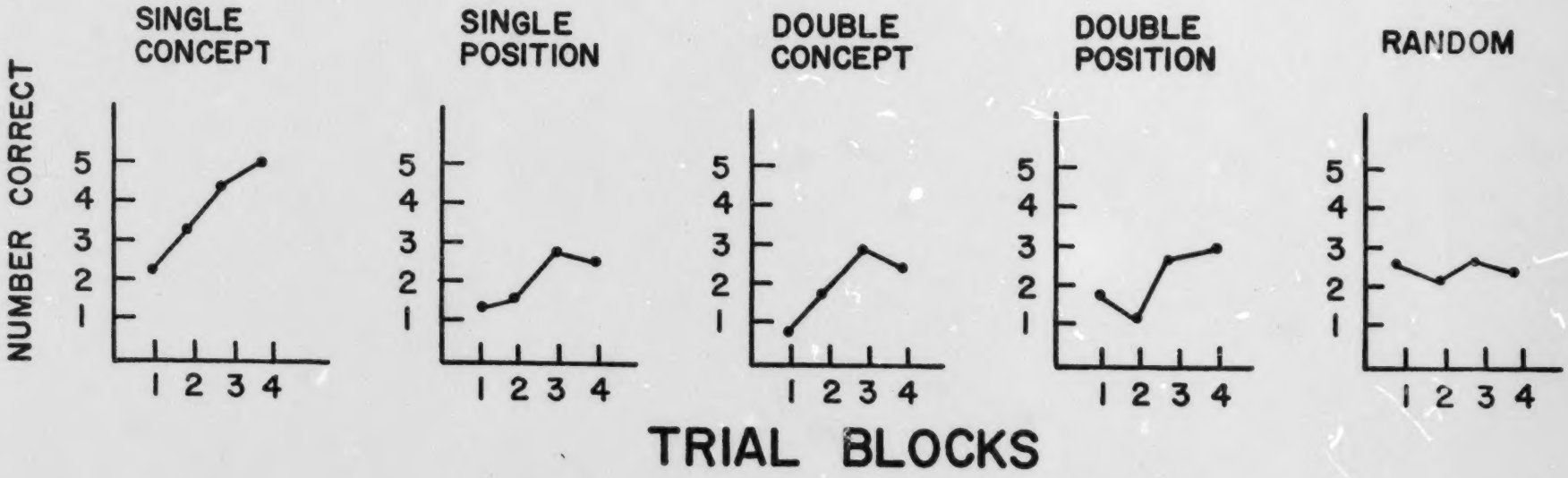
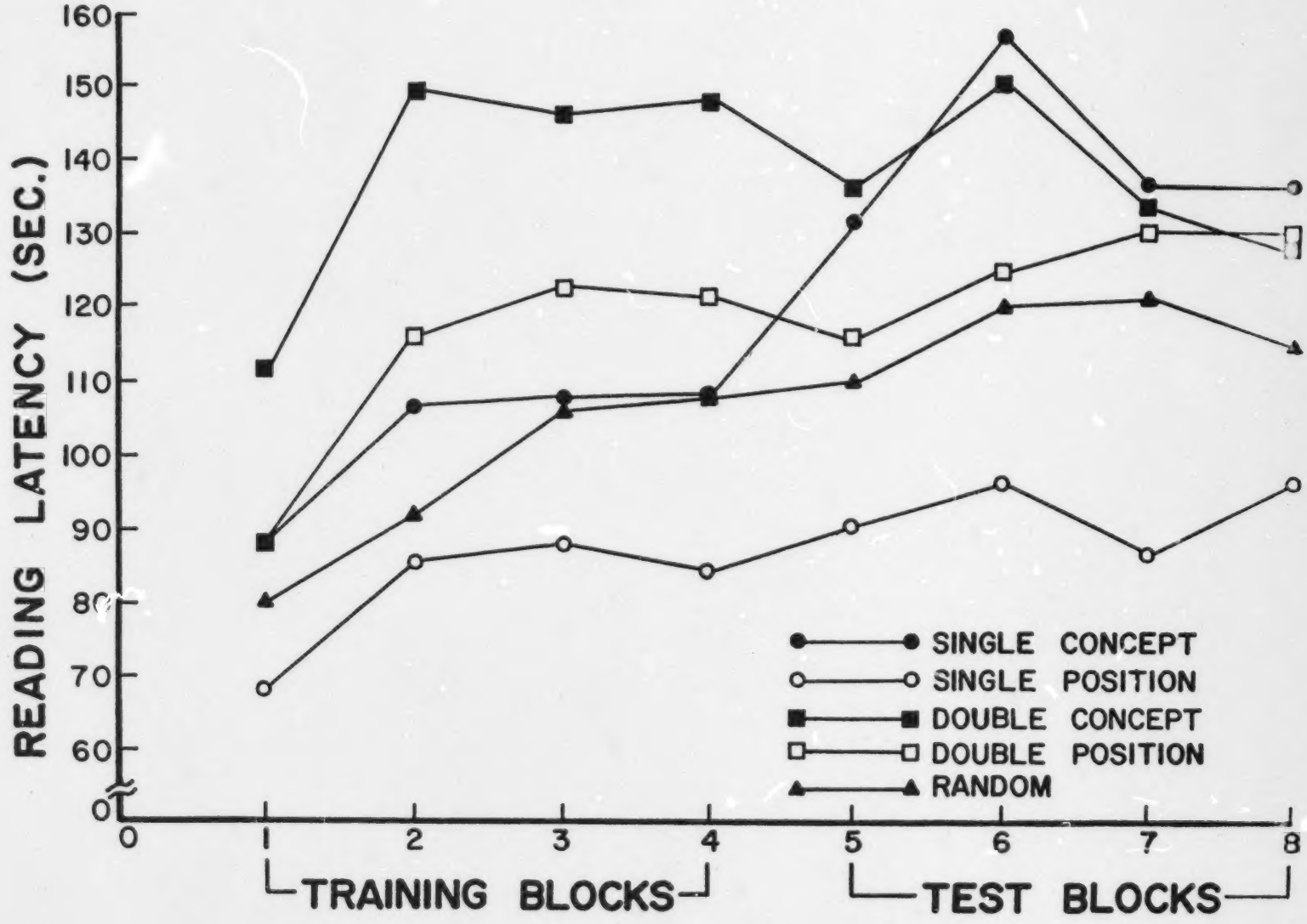

SINGLE CONCEPT
SINGLE POSITION
DOUBLE CONCEPT
DOUBLE POSITION
RANDOM
NUMBER CORRECT
1
2
3
4
5
1 2 3 4
TRIAL BLOCKS

Fig. 2: Summed reading latencies for five-trial blocks during training and test phases.


READING LATENCY (SEC.)
160
150
140
130
120
110
100
90
80
70
60
0
0
1
2
3
4
5
6
7
8
TRAINING BLOCKS
TEST BLOCKS
SINGLE CONCEPT
SINGLE POSITION
DOUBLE CONCEPT
DOUBLE POSITION
RANDOM